



(12) **EUROPEAN PATENT APPLICATION**

(43) Date of publication:  
**12.12.2018 Bulletin 2018/50**

(21) Application number: **18175187.6**

(22) Date of filing: **30.05.2018**

(51) Int Cl.:  
**G02F 1/1335** (2006.01) **G02B 5/30** (2006.01)  
**G02B 27/28** (2006.01) **G02C 7/12** (2006.01)  
**G02B 27/00** (2006.01) **G01N 21/21** (2006.01)  
**G02B 27/01** (2006.01)

(84) Designated Contracting States:  
**AL AT BE BG CH CY CZ DE DK EE ES FI FR GB  
GR HR HU IE IS IT LI LT LU LV MC MK MT NL NO  
PL PT RO RS SE SI SK SM TR**  
Designated Extension States:  
**BA ME**  
Designated Validation States:  
**KH MA MD TN**

(30) Priority: **08.06.2017 US 201715617590**

(71) Applicant: **Visteon Global Technologies, Inc.  
Van Buren Township, MI (US)**

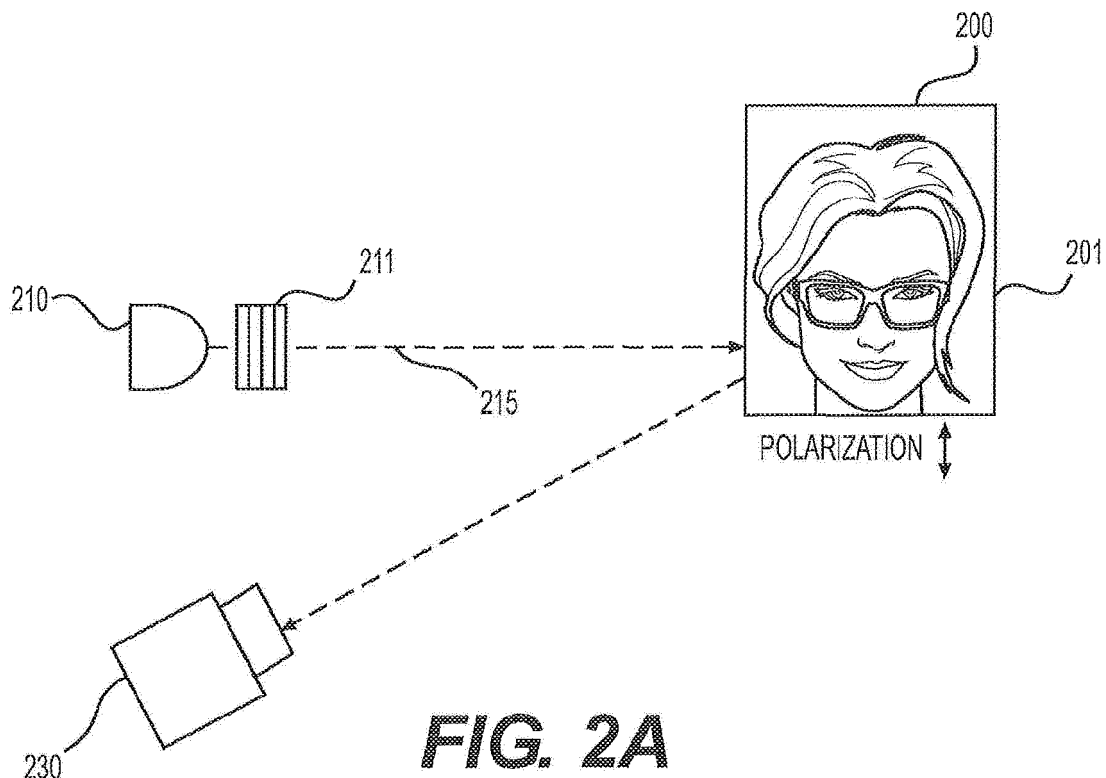
(72) Inventors:  
• **WEINDORF, Paul Fredrick Luther**  
Novi, MI 48377 (US)  
• **HAYDEN, Brian John**  
Royal Oak, MI 48073 (US)  
• **LOR, Kong Phong**  
Warren, MI 48093 (US)

(74) Representative: **Dummett Copp LLP**  
**25 The Square**  
**Martlesham Heath**  
**Ipswich IP5 3SL (GB)**

(54) **DETECTING POLARIZATION OF A VIEWER'S EYEWEAR**

(57) Disclosed herein are systems, methods, and devices for detecting a polarization of eyewear worn by a viewer gazing at an electronic display. The detection disclosed herein may be employed to control and adjust the electronic display to compensate for the effects of polar-

ization. The systems disclosed herein incorporate an embodiment with two IR sources, and an embodiment employing a single IR source coupled with electro-optical devices.



**FIG. 2A**

## Description

### Background

[0001] Electronic displays are provided in many contexts to electronically render digital information to a viewer. The electronic displays receive information, and render the information through lighted cells in patterns that reflect the texts and pictures employed to convey the information.

[0002] A head-up display (HUD) allows a viewer to view not only the lighted information, but due to the transparent nature of the HUD, the view through the HUD. Thus, a viewer may be delivered information while not losing the ability to view the real world through the HUD.

[0003] As shown in FIG. 1, a HUD 100 may include at least a projection unit 110 (or picture generating source), a combiner 120, and a video generation video generation computer 130. Although shown as separate components, all the elements together compose a singular HUD implementation.

[0004] The projection unit 110 in a HUD 100 has a convex lens or concave mirror with a light emitting technology (for example, a Cathode Ray Tube (CRT), light emitting diode, or liquid crystal display at its focus). This setup produces an image where the light is collimated, i.e. the focal point is perceived to be in front of the windscreen at a predetermined distance.

[0005] The combiner 120 is typically an angled flat or curved piece of glass located directly in front of the viewer, that redirects the projected image from a projection unit 110 in such a way as to see the field of view and the projected image at the same time. Combiners 120 may have special coatings that reflect the light projected onto it from the projector unit 110 while allowing all other wavelengths of light to pass through. In some optical layouts, combiners may also have a curved surface to refocus the image from the projecting unit 110. In some optical layouts, combiners may also have a curved surface to provide additional dioptric power to the projecting unit 110 to magnify the image.

[0006] The video generation computer 130 provides the interface between the HUD 100 and the systems/data to be displayed and generates the imagery to be displayed by the projection unit 110.

[0007] In certain HUD applications, the illumination may be provided with additional properties to improve the image. One such technique employed in HUD applications is the use of s-polarization (i.e. an s-polarized optical wave). S-polarization adds optical power to the content being displayed because of a higher reflectivity associated with the s-polarization.

[0008] In certain HUD applications, only s-polarization (i.e. an s-polarized optical wave) content is displayed. The main reason to employ s-polarization in a HUD implementation is that in some designs there is no coating on the combiner or polarization dependent structure (e.g. grating). Thus, the reflectivity of s-polarization is always

greater than the reflectivity of p-polarization.

[0009] However, many viewers employ eyewear or other viewing devices that preferentially pass p-polarization (for example, sunglasses) and block or attenuate s-polarization. These devices are employed to avoid deleterious effects caused by environmental conditions, such as sun light reflected from surfaces.

[0010] Thus, by employing an s-polarization component with eyewear that employs p-polarization, the viewer of the HUD is left with a degraded or non-visible image. Several techniques may be employed to address this, such as providing a quarter-wave plate. However, this solution requires additional power to maintain the brightness when a viewer is not wearing a polarized eyewear device.

### Summary

[0011] The following description relates to systems, methods, and applications for detecting polarization of a viewer's eyewear. Exemplary embodiments may also be directed to any of the system, the method, or an application disclosed herein, and the subsequent adjustment of a display (for example a HUD) based on the same.

[0012] Additional features of the invention will be set forth in the description which follows, and in part will be apparent from the description, or may be learned by practice of the invention.

[0013] The aspects disclosed herein relate to a system for detecting polarization of a viewer's eyewear being worn on the viewer's face. This system includes at least a first IR source oriented at the viewer's face; a second IR source orientated at the viewer's face; a horizontal polarization plate disposed between the first IR source and the viewer's face; a vertical polarization plate disposed between the second IR source the viewer's face; a camera to detect reflected images from the viewer's face; and a microprocessor to control the first IR source, the second IR source, and the camera, and to determine the viewer's eyewear.

[0014] Also disclosed herein is a system for detecting polarization of a viewer's eyewear. The system includes an IR source oriented at the viewer's face; a polarizer provided in the path between the IR source and the viewer's face; an electro-optical device in abutment with the polarizer, and in between the polarizer and the viewer's face; a camera to detect reflected images from the viewer's face; and a microprocessor to control the IR source, the electro-optical device, and the camera, and to determine the viewer's eyewear.

[0015] Also disclosed herein is a system for detecting polarization of a viewer's eyewear. The system includes a camera to detect reflected images from the viewer's face; a polarizer provided in the path between the viewer's face and the camera; an electro-optical device in abutment with the polarizer, and in between the polarizer and the viewer's face; a microprocessor to control the IR source, the electro-optical device, and the camera, and

to determine the viewer's eyewear.

**[0016]** Also disclosed herein is a system for detecting polarization of a viewer's eyewear. The system includes an IR source oriented at the viewer's face; a camera to detect reflected images from the viewer's face; a first polarizer provided in the path between the viewer's face and the camera; a first electro-optical device in abutment with the first polarizer, and in between the first polarizer and the viewer's face; a second polarizer provided in the path between the IR source and the viewer's face; a second electro-optical device in abutment with the second polarizer, and in between the second polarizer and the viewer's face; a microprocessor to control the IR source, the first and second electro-optical devices, and the camera, and to determine the viewer's eyewear.

**[0017]** Also disclosed herein is a system for detecting polarization of a viewer's eyewear. The system includes a first camera directed at the viewer's face; a second camera directed at the viewer's face; an IR source oriented at the viewer's face; a horizontal polarization plate disposed between the first camera and the viewer's face; a vertical polarization plate disposed between the second camera and the viewer's face; and a microprocessor to control the IR source the first camera, and the second camera, and to determine the viewer's eyewear.

**[0018]** In each case above, the first IR source and the second IR source may generate light at a wavelength between 700 nm to 1050 nm, but preferably within 825-875 nm, and most preferably 850 nm.

**[0019]** In each case above, in which there is a polarizing element having a fixed polarization, the polarizing element may be a wire-grid polarizer.

**[0020]** It is to be understood that both the foregoing general description and the following detailed description are exemplary and explanatory and are intended to provide further explanation of the invention as claimed. Other features and aspects will be apparent from the following detailed description, the drawings, and the claims.

### **Description of the Drawings**

**[0021]** The detailed description, which is given by way of example only, refers to the following drawings, in which like numerals refer to like items, and in which:

FIG. 1 illustrates a HUD implementation according to the prior art;

FIGS. 2(a) and 2(b) illustrate an example implementation of a system for detecting polarization of eyewear according to a first embodiment;

FIG. 3 illustrates a method for performing the detection of FIGS. 2(a) and (b);

FIG. 4 illustrates an example implementation of a system for detecting polarization of eyewear according to a second embodiment;

FIGS. 5(a) and 5(b) illustrate an operation of the electro-optical device of FIG. 4;

FIG. 6 illustrates an example implementation of a system for detecting polarization of eyewear according to a third embodiment; and

FIG. 7 illustrates another embodiment of a system employing the aspects disclosed herein.

### **Detailed Description**

**[0022]** The invention is described more fully hereinafter with references to the accompanying drawings, in which exemplary embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein. Rather, these exemplary embodiments are provided so that this disclosure is thorough, and will fully convey the scope of the invention to those skilled in the art. It will be understood that for the purposes of this disclosure, "at least one of each" will be interpreted to mean any combination of the enumerated elements following the respective language, including combination of multiples of the enumerated elements. For example, "at least one of X, Y, and Z" will be construed to mean X only, Y only, Z only, or any combination of two or more items X, Y, and Z (e.g. XYZ, XZ, YZ, X). Throughout the drawings and the detailed description, unless otherwise described, the same drawing reference numerals are understood to refer to the same elements, features, and structures. The relative size and depiction of these elements may be exaggerated for clarity, illustration, and convenience.

**[0023]** As explained above, the HUD is becoming more commonplace in vehicle-based implementations. The HUD allows a viewer of the HUD to view content on the combiner, while simultaneously viewing the landscape beyond the combiner. Thus, the HUD provides an enhanced implementation of the display experience.

**[0024]** In certain contexts, for example vehicles, the HUD is naturally suited for implementation. Vehicles often have combiners as part of the windshield (or front window). In other implementations, the combiner may be implemented on any transparent surface provided with a vehicle.

**[0025]** As explained above, if a viewer wears sunglasses (or any eyewear), the content on the HUD may be not viewable. This is due to either natural phenomena causing the content on the HUD to be polarized with a specific polarization, or through a conscious choice by the implementer to employ the specific polarization. Thus, if the eyewear is of a different polarization (for example p-polarization or some polarization between p and s), the content on the HUD becomes degraded or non-visible.

**[0026]** Disclosed herein are methods and systems provided to detect the polarization of eyewear worn by a viewer of a display (such as a HUD). By employing the

concepts disclosed herein, the implementer of these systems may detect whether the viewer is wearing glasses of a specific polarization. In another embodiment, the methods and systems disclosed herein may advantageously be provided with additional control capabilities to adjust a HUD based on the detection.

**[0027]** The aspects disclosed herein employ a combination of at least one infrared (IR) sourced light, a variably-provided polarization plate, and a camera. Employing the aspects disclosed herein, it may be achievable to detect whether the viewer is wearing polarized eyewear, and the type of polarized lens being worn.

**[0028]** FIGS. 2(a) and (b) illustrate an example of a system to determine if a viewer is wearing polarized eyewear according to a first embodiment. As shown in FIGS. 2(a) and (b), an IR light source 210, and an IR light source 220 are shown. Also shown, are a vertical polarization plate 211 and a horizontal polarization plate 221.

**[0029]** A camera 230 is also provided. Both the camera 230 and the light sources 210, 220 are oriented towards eyes of the viewer 200. The various elements shown in FIGS. 2(a) and (b) may be controlled via instructions provided in a microprocessor (not shown). The instructions may be configured according to a method 300, illustrated in FIG. 3, which illustrates a flowchart of the method 300 employable via a microprocessor provided to control the elements in FIGS. 2(a) and (b).

**[0030]** In operation 310, an application is started to detect the polarization of eyewear worn by the viewer 200. After the application is started, the IR sources 210, 220 are each individually pulsed 320 and projected along first and second optical paths 215 and 225 respectively, with the camera 230 capturing an image of the viewer's 200 face during each pulse.

**[0031]** As shown in both FIGS. 2(a) and (b), the first optical path 215 propagates through a vertical polarizer, while the second optical path 225 propagates through a horizontal polarizer. Thus, each polarizer selectively passes polarized IR light from the IR sources 210, 220, based on the provided polarization, which may, for example, be unpolarized, but will at least have a polarization component corresponding with the each polarizer.

**[0032]** Thus, after operation 320, a first image associated with a first IR source 210 flashing IR light may be obtained, as well as a second image associated with a second IR source 220. Flashing IR light may be obtained. These two images are stored. In operation 330, a region-of-interest (ROI) in the image is obtained through image recognition techniques. The ROI is defined as the area of the viewer 200's face containing eyewear.

**[0033]** In operation 340, the average intensity of both images is derived through image processing technology. The average intensity (or grayscale intensity) may be derived for each image, with a delta between the images being calculated (350). In operation 360, a determination is made as to whether the ROI delta is over a predetermined threshold. The predetermined threshold may be set as a difference between detecting a surface of a lens

of eyewear and an average of skin-types visible through the polarized lenses. This predetermined threshold may be set based on finding a tolerance employable with a whole host of commercially available eyewear offerings. If the ROI delta is over the threshold, in operation 370, an indication is made that the viewer 200 is wearing polarized eyewear. If not, the method 300 proceeds back to operation 320 (to be performed repeatedly).

**[0034]** After the indication is made, the method 300 (via pathway 371) may also return to operation 320, and so that subsequent steps are performed repeatedly.

**[0035]** FIGS. 2(a) and (b) also illustrates the phenomena that allows the method 300 in FIG. 3 to be effective. As shown, in FIG. 2(a), the viewer 200's eyes are visible in a first image 201 captured by the camera 230. Conversely, in FIG. 2(b), the opposite is true based on a second image 202 captured by the camera 230. This is due to the fact that the eyewear is vertically polarized (passes p-polarization). Thus, the light propagated along the first optical path 215 is able to illuminate the portions of the face behind the eyewear. For the same reasons, the light propagated along the second optical path 225 is incapable of showing anything behind the eyewear in FIG. 2(b). This allows the image contrast (or grayscale contrast) between the first and second images 201, 202 to differ, thereby allowing detection of polarized lenses.

**[0036]** As such, the amount of contrast differs between the first and second image 201, 202, leading to the detection in operation 370 that the viewer 200 is wearing polarized eyewear.

**[0037]** The inventors have performed tests and have found employing a light with a wavelength within 825-875 nm (and most preferably 850 nm) allows for an optimal detection. Tests performed have indicated that the wavelength range disclosed above leads to optimal detection. The wavelength may, however, be between 700 nm to 1050 nm, but preferably within 825-875 nm, and most preferably 850 nm.

**[0038]** FIG. 4 illustrates a second embodiment of the aspects disclosed herein. As shown in FIG. 4, a single IR source 400 is provided. Additionally, a wire-grid polarizer 410 is also provided. In abutment with the wire-grid polarizer 410 is a liquid crystal cell (or electro-optical device) 420. The electro-optical device 420 will be explained in greater detail with the explanation in FIG. 5.

**[0039]** The system in FIG. 4 illustrates how only one IR source may be employed to detect polarized eyewear, rather than the two shown in FIG. 2.

**[0040]** Wire-grid polarizer 410 is used, because the inventors have discovered that other polarizers (such as dye and iodine polarizers) lose their polarization properties in the IR region (850-950 nm). However, the wire-grid polarizer 410 provides superior operation with IR wavelengths required to operate with the various systems disclosed herein.

**[0041]** As shown in FIGS. 5(a) and (b), the electro-optical device 420, which may be a twisted nematic (TN) cell for example, controls the rotation of the polarized

light from the wire-grid polarizer 410 when the voltage 510 is applied to the electro-optical device 420. Therefore, if the wire-grid transmission axis is horizontal (x direction), then with no voltage 510 (FIG. 5(a)) on the electro-optical device 420, the polarized light is rotated to the vertical orientation. When voltage 510 (FIG. 5(b)) is applied to the electro-optical device 420, the polarized light from the wire-grid polarizer 410 is not rotated and IR polarization remains horizontal. The wire-grid polarizer 410 may be oriented for a vertical transmission axis and in this case vertically polarized light transmits through the electro-optical device 420 when voltage 510 is applied and is rotated horizontally when voltage 510 is not applied.

**[0042]** As shown, the power source (voltage) 510 is connected to a first node 530 of the electro-optical device 420 and a second node 540. Thus, when the switch shown in FIGS. 5(a) and (b) is closed, and voltage is applied across nodes 530 and 540, the orientation of liquid crystals 520 also changes from horizontal to vertical.

**[0043]** Thus, employing the aspects disclosed herein. The electro-optical device 420 may change states in operation 320, thereby allowing a camera 230 to capture the viewer 200's eyewear area in condition where IR is transmitted horizontally and vertically.

**[0044]** FIG. 6 illustrates a third embodiment of the aspects disclosed herein. In FIG. 6, the camera 230 is provided with the wire-grid polarizer 410 and the electro-optical device 420. In the embodiment shown in FIG. 6, the polarization of the electro-optical device 420 is switched similarly to the embodiment shown in FIG. 4.

**[0045]** One of the advantages of using the polarization analyzer in front of the camera is that the ambient IR in the sunlight actually helps rather than fights the IR source. In fact, an extension of the system would extend the camera IR filter to include part of or the entire visible spectrum.

**[0046]** A fourth embodiment is also disclosed. In a fourth embodiment, the polarizer 410 and electro-optical polarization rotator 420 are placed at both the camera portion 230 of the system and by the IR source 400. By employing the elements at both locations, the detection of the difference employed in the determination of operation 370 improves.

**[0047]** FIG. 7 illustrates a fifth embodiment of a system employing the aspects disclosed herein. As shown in FIG. 7, there is a single IR source 210. The IR source 210 is configured to pulse an IR light towards a viewer's face. In response, the reflection is captured by the camera 230 and a second camera 240. In between each camera is a vertical polarizer 231 and a horizontal polarizer 241, respectively.

**[0048]** Employing the concepts disclosed herein, the microprocessor may employ the image detection as discussed above to determine the polarization of the eyewear being worn by the viewer 200.

**[0049]** Certain of the devices shown include a computing system. The computing system includes a processor

(CPU) and a system bus that couples various system components including a system memory such as read only memory (ROM) and random access memory (RAM), to the processor. Other system memory may be available for use as well. The computing system may include more than one processor or a group or cluster of computing systems networked together to provide greater processing capability. The system bus may be any of several types of bus structures including a memory bus or memory controller, a peripheral bus, and a local bus using any of a variety of bus architectures. A basic input/output (BIOS) stored in the ROM or the like, may provide basic routines that help to transfer information between elements within the computing system, such as during start-up. The computing system further includes data stores, which maintain a database according to known database management systems. The data stores may be embodied in many forms, such as a hard disk drive, a magnetic disk drive, an optical disk drive, tape drive, or another type of computer readable media which can store data that are accessible by the processor, such as magnetic cassettes, flash memory cards, digital versatile disks, cartridges, random access memories (RAMs) and, read only memory (ROM). The data stores may be connected to the system bus by a drive interface. The data stores provide non-volatile storage of computer readable instructions, data structures, program modules and other data for the computing system.

**[0050]** To enable human (and in some instances, machine) user interaction, the computing system may include an input device, such as a microphone for speech and audio, a touch sensitive screen for gesture or graphical input, keyboard, mouse, motion input, and so forth. An output device can include one or more of a number of output mechanisms. In some instances, multimodal systems enable a user to provide multiple types of input to communicate with the computing system. A communications interface generally enables the computing device system to communicate with one or more other computing devices using various communication and network protocols.

**[0051]** Embodiments disclosed herein can be implemented in digital electronic circuitry, or in computer software, firmware, or hardware, including the herein disclosed structures and their equivalents. Some embodiments can be implemented as one or more computer programs, i.e., one or more modules of computer program instructions, encoded on a tangible computer storage medium for execution by one or more processors. A computer storage medium can be, or can be included in, a computer-readable storage device, a computer-readable storage substrate, or a random or serial access memory. The computer storage medium can also be, or can be included in, one or more separate tangible components or media such as multiple CDs, disks, or other storage devices. The computer storage medium does not include a transitory signal.

**[0052]** As used herein, the term processor encom-

passes all kinds of apparatus, devices, and machines for processing data, including by way of example a programmable processor, a computer, a system on a chip, or multiple ones, or combinations, of the foregoing. The processor can include special purpose logic circuitry, e.g., an FPGA (field programmable gate array) or an ASIC (application-specific integrated circuit). The processor also can include, in addition to hardware, code that creates an execution environment for the computer program in question, e.g., code that constitutes processor firmware, a protocol stack, a database management system, an operating system, a cross-platform runtime environment, a virtual machine, or a combination of one or more of them.

**[0053]** A computer program (also known as a program, module, engine, software, software application, script, or code) can be written in any form of programming language, including compiled or interpreted languages, declarative or procedural languages, and the program can be deployed in any form, including as a stand-alone program or as a module, component, subroutine, object, or other unit suitable for use in a computing environment. A computer program may, but need not, correspond to a file in a file system. A program can be stored in a portion of a file that holds other programs or data (e.g., one or more scripts stored in a markup language document), in a single file dedicated to the program in question, or in multiple coordinated files (e.g., files that store one or more modules, sub-programs, or portions of code). A computer program can be deployed to be executed on one computer or on multiple computers that are located at one site or distributed across multiple sites and interconnected by a communication network.

**[0054]** To provide for interaction with an individual, the herein disclosed embodiments can be implemented using an interactive display, such as a graphical user interface (GUI). Such GUI's may include interactive features such as pop-up or pull-down menus or lists, selection tabs, scannable features, and other features that can receive human inputs.

**[0055]** The computing system disclosed herein can include clients and servers. A client and server are generally remote from each other and typically interact through a communications network. The relationship of client and server arises by virtue of computer programs running on the respective computers and having a client-server relationship to each other. In some embodiments, a server transmits data (e.g., an HTML page) to a client device (e.g., for purposes of displaying data to and receiving user input from a user interacting with the client device). Data generated at the client device (e.g., a result of the user interaction) can be received from the client device at the server.

**[0056]** Various combinations of cameras, IR sources, polarization plates, and electro-optical devices are illustrated above. Others not described, but employable using the concepts disclosed herein, may be available based on this disclosure.

**[0057]** It will be apparent to those skilled in the art that various modifications and variation can be made in the present invention without departing from the scope of the invention. Thus, it is intended that the present invention cover the modifications and variations of this invention provided they come within the scope of the appended claims.

## 10 Claims

1. A system for detecting polarization of a viewer's eyewear being worn on the viewer's face, comprising:

a first infra-red (IR) source oriented at the viewer's face;  
a second IR source orientated at the viewer's face;  
a horizontal polarization plate disposed between the first IR source and the viewer's face;  
a vertical polarization plate disposed between the second IR source the viewer's face;  
a camera to detect reflected images from the viewer's face; and  
a microprocessor, the microprocessor being configured to control the first IR source, the second IR source, and the camera, and to determine the viewer's eyewear.

2. The system according to claim 1, wherein the microprocessor is configured to perform the following:

generating a first IR light from the first IR source, and capturing a first image of the viewer's face;  
generating a second IR light from the second IR source, and capturing a second image of the viewer's face, and  
performing an analysis on the first image and the second image to perform the determination.

3. A system for detecting polarization of a viewer's eyewear being worn on the viewer's face, comprising:

an infra-red (IR) source oriented at the viewer's face;  
a polarizer provided in the path between the IR source and the viewer's face;  
an electro-optical device in abutment with the polarizer, and in between the polarizer and the viewer's face;  
a camera to detect reflected images from the viewer's face; and  
a microprocessor, the microprocessor being configured to control the IR source, the electro-optical device, and the camera, and to determine the viewer's eyewear.

4. The system according to claim 3, wherein the micro-

processor is configured to perform the following:

generating a first IR light from the IR source,  
controlling the electro-optical device to be in a  
first orientation, and capturing a first image of  
the viewer's face; 5  
generating a second IR light from the IR source,  
controlling the electro-optical device to be in a  
second orientation, and capturing a second im-  
age of the viewer's face, and 10  
performing an analysis on the first image and  
the second image to perform the determination,  
wherein the first orientation and the second ori-  
entation are defined as states of liquid crystals  
being either horizontal or vertical. 15

5. A system for detecting polarization of a viewer's eye-  
wear being worn on the viewer's face, comprising:

an infra-red (IR) source oriented at the viewer's  
face; 20  
a camera to detect reflected images from the  
viewer's face;  
a polarizer provided in the path between the  
viewer's face and the camera; 25  
an electro-optical device in abutment with the  
polarizer, and in between the polarizer and the  
viewer's face;  
a microprocessor, the microprocessor being  
configured to control the IR source, the electro-  
optical device, and the camera, and to determine  
the viewer's eyewear. 30

6. The system according to claim 5, wherein the micro-  
processor is configured to perform the following: 35

generating a first IR light from the IR source,  
controlling the electro-optical device to be in a  
first orientation, and capturing a first image of  
the viewer's face; 40  
generating a second IR light from the IR source,  
controlling the electro-optical device to be in a  
second orientation, and capturing a second im-  
age of the viewer's face, and  
performing an analysis on the first image and 45  
the second image to perform the determination,  
wherein the first orientation and the second ori-  
entation are defined as states of liquid crystals  
being either horizontal or vertical.

7. A system for detecting polarization of a viewer's eye-  
wear being worn on the viewer's face, comprising:

an infra-red (IR) source oriented at the viewer's  
face; 50  
a camera to detect reflected images from the  
viewer's face;  
a first polarizer provided in the path between the

viewer's face and the camera;  
a first electro-optical device in abutment with the  
first polarizer, and in between the first polarizer  
and the viewer's face;  
a second polarizer provided in the path between  
the IR source and the viewer's face;  
a second electro-optical device in abutment with  
the second polarizer, and in between the second  
polarizer and the viewer's face;  
a microprocessor, the microprocessor being  
configured to control the IR source, the first and  
second electro-optical devices, and the camera,  
and to determine the viewer's eyewear.

8. The system according to claim 7, wherein the micro-  
processor is configured to perform the following:

generating a first IR light from the IR source,  
controlling the first and the second electro-opti-  
cal device to be in a first orientation, and cap-  
turing a first image of the viewer's face;  
generating a second IR light from the IR source,  
controlling the first and the second electro-opti-  
cal device to be in a second orientation, and cap-  
turing a second image of the viewer's face, and  
performing an analysis on the first image and  
the second image to perform the determination,  
wherein the first orientation and the second ori-  
entation are defined as states of liquid crystals  
being either horizontal or vertical.

9. A system for detecting polarization of a viewer's eye-  
wear being worn on the viewer's face, comprising:

a first camera directed at the viewer's face;  
a second camera directed at the viewer's face;  
an infra-red (IR) source orientated at the view-  
er's face;  
a horizontal polarization plate disposed between  
the first camera and the viewer's face;  
a vertical polarization plate disposed between  
the second camera and the viewer's face; and  
a microprocessor, the microprocessor being  
configured to control the IR source the first cam-  
era, and the second camera, and to determine  
the viewer's eyewear.

10. The system according to claim 9, wherein the micro-  
processor is configured to perform the following:

generating a first IR light from the IR source, and  
capturing a first image of the viewer's face via  
the first camera, and a second image of the view-  
er's face via the second camera; and  
performing an analysis on the first image and  
the second image to perform the determination.

11. The system according to any one of claims 2, 4, 6,

8 or 10, wherein the analysis comprises the following steps:

performing image analysis on the first image and the second image to determine an eyewear location of the viewer's face; 5  
 detecting a greyscale amount between the first image and the second image;  
 calculating a delta from the detected greyscale amount; and 10  
 in response to the delta being over a predetermined threshold, indicating that the viewer is wearing polarized eyewear.

12. The system according to claim 11, wherein the indication is communicated to a head-up display (HUD) to adjust the HUD to compensate for the detected polarization. 15

13. The system according to claim 1, further comprising a first electro-optical device in abutment with a second horizontal polarizer in front of the camera, and in between the second horizontal polarizer and the viewer's face; and 20  
 a second electro-optical device in abutment with a second vertical polarizer in front of the camera, and in between the second vertical polarizer and the viewer's face, 25  
 wherein the microprocessor is further configured to control the first electro-optical device and the second electro-optical device. 30

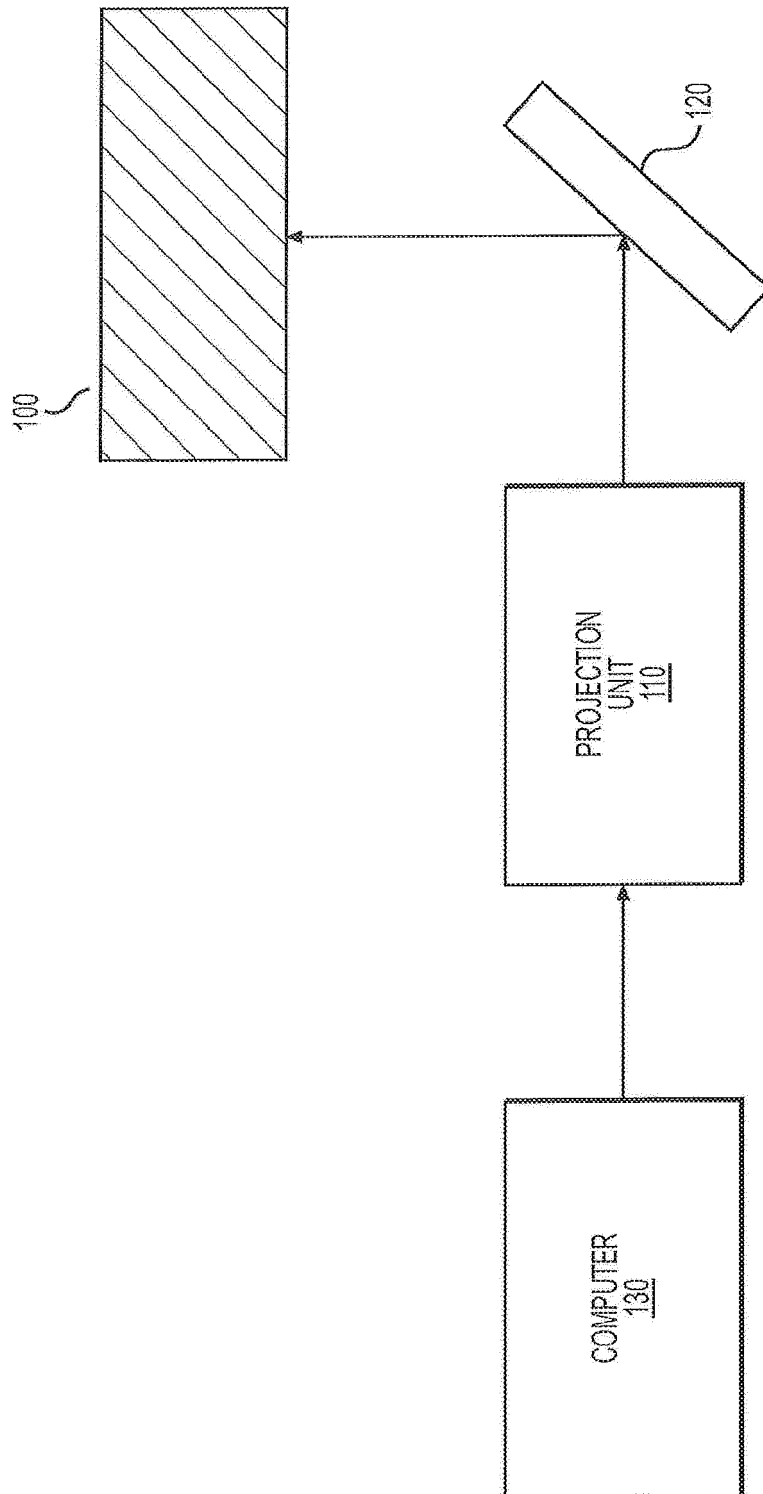
14. The system according to claim 1, further comprising a first camera directed at the viewer's face;  
 a second camera directed at the viewer's face; 35  
 a horizontal polarization plate disposed between the first camera and the viewer's face; and  
 a vertical polarization plate disposed between the second camera and the viewer's face;  
 wherein the microprocessor is further configured to control the first camera and the second camera. 40

15. The system according to claim 3, further comprising:

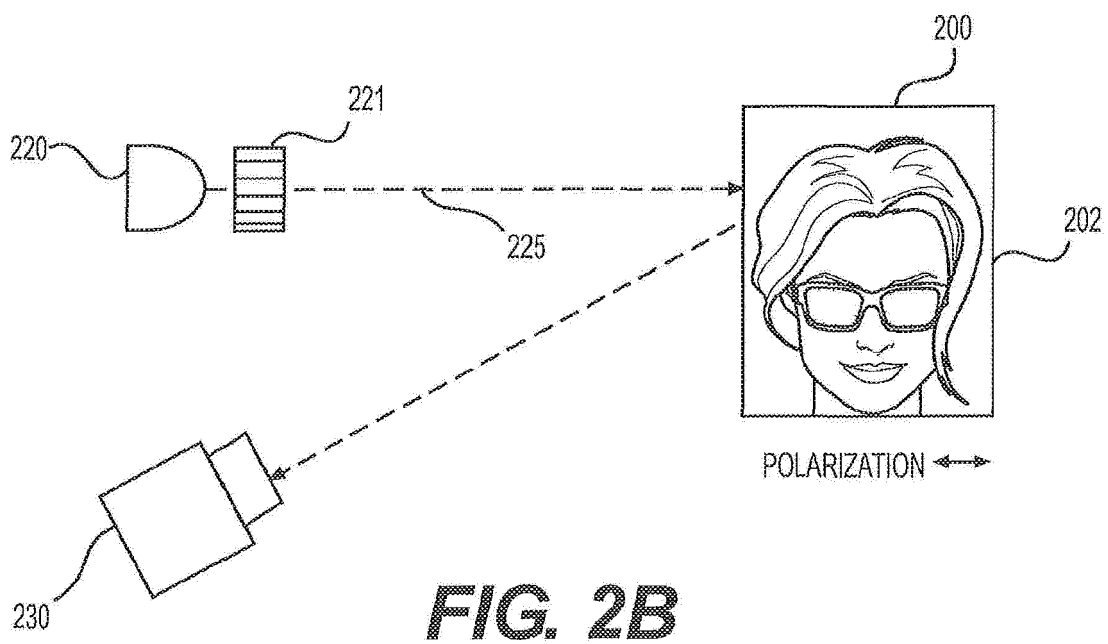
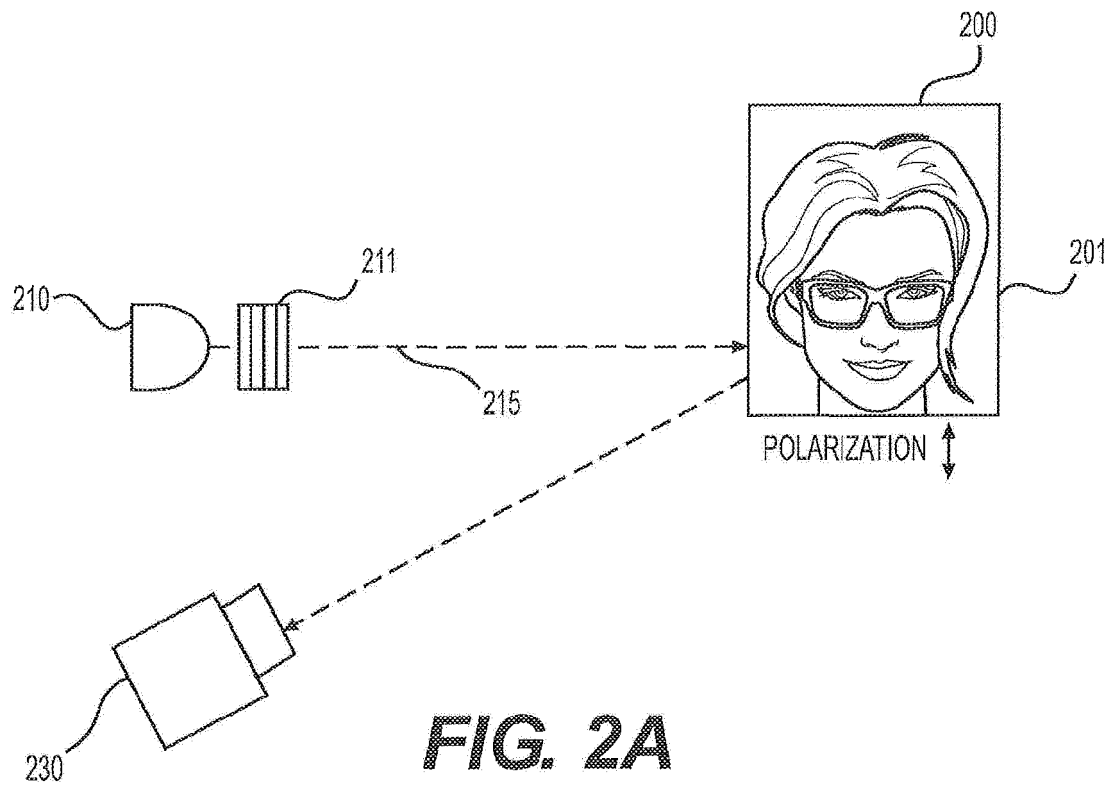
a second camera directed at the viewer's face; 45  
 a horizontal polarization plate disposed between the camera and the viewer's face; and  
 a vertical polarization plate disposed between the second camera and the viewer's face;  
 wherein the microprocessor is further configured to control the second camera. 50

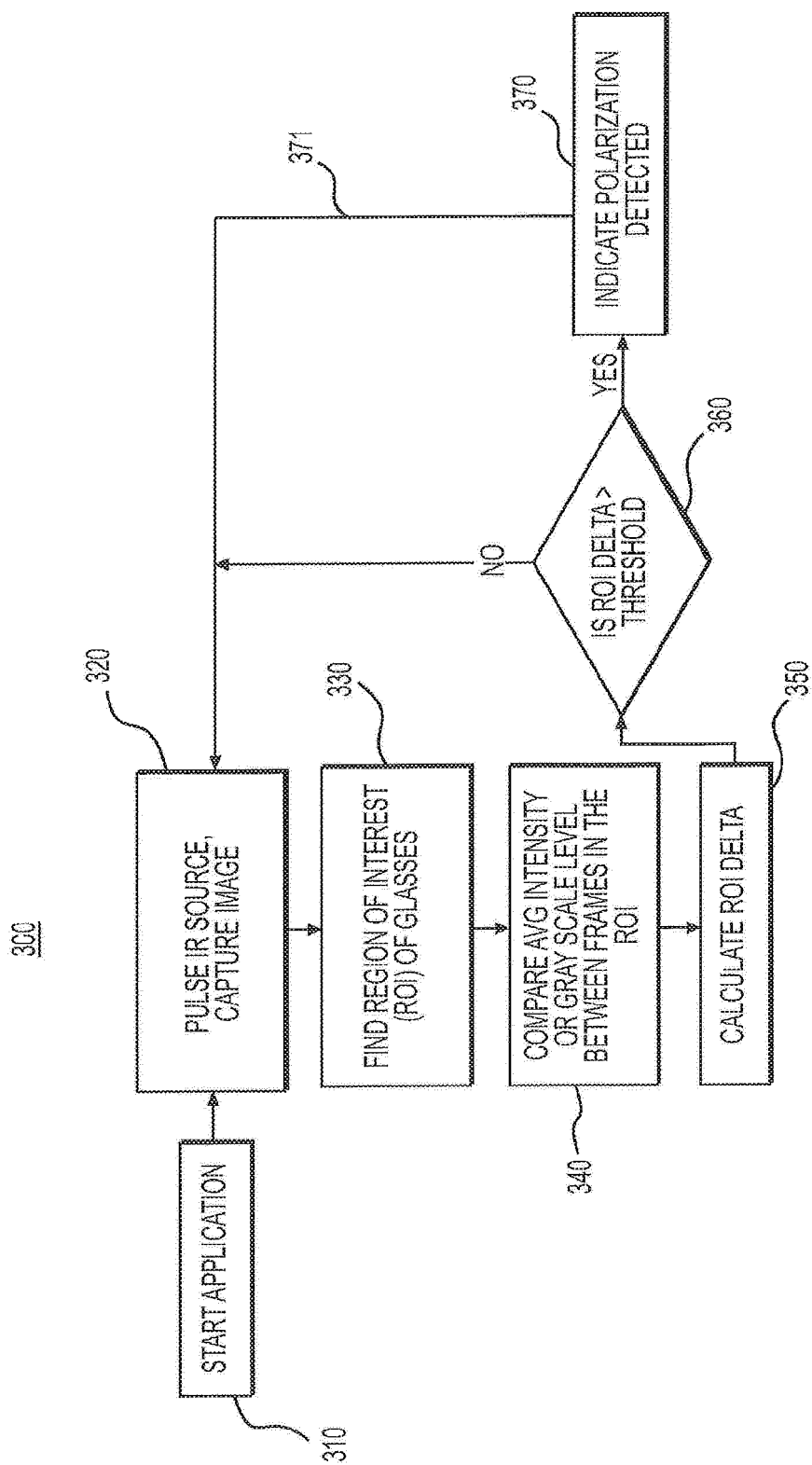
55

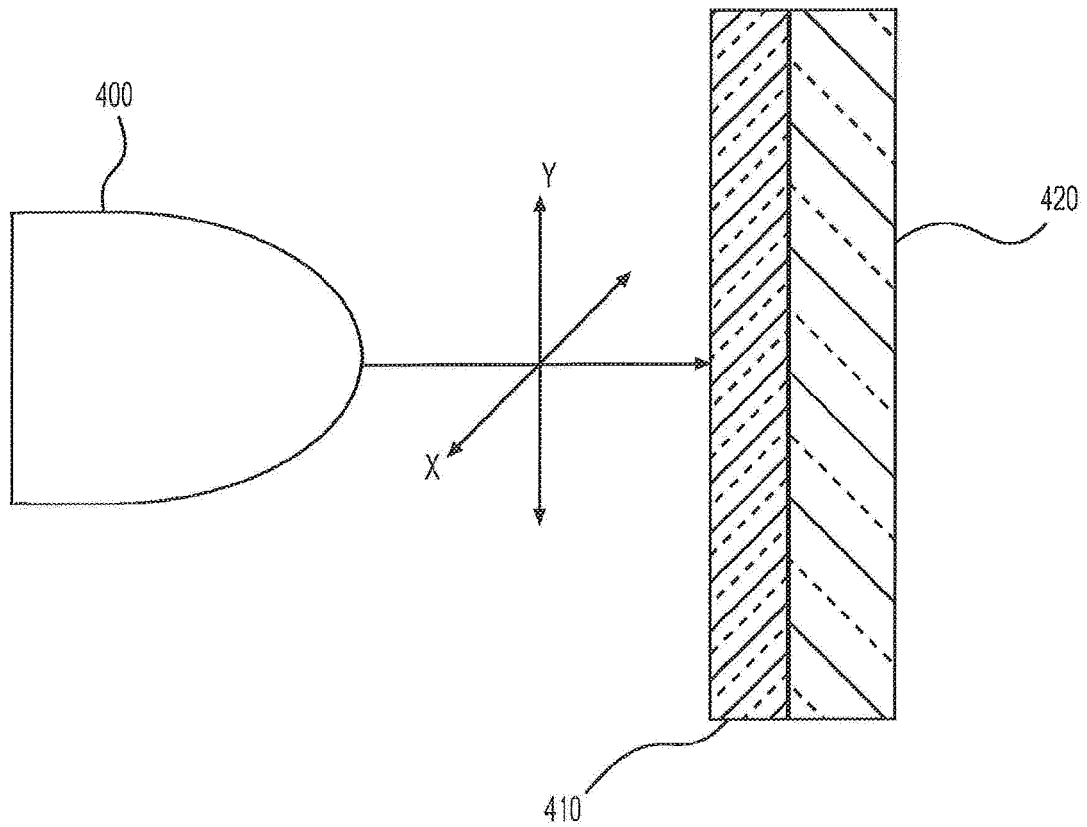




**FIG. 1**



**FIG. 3**



**FIG. 4**

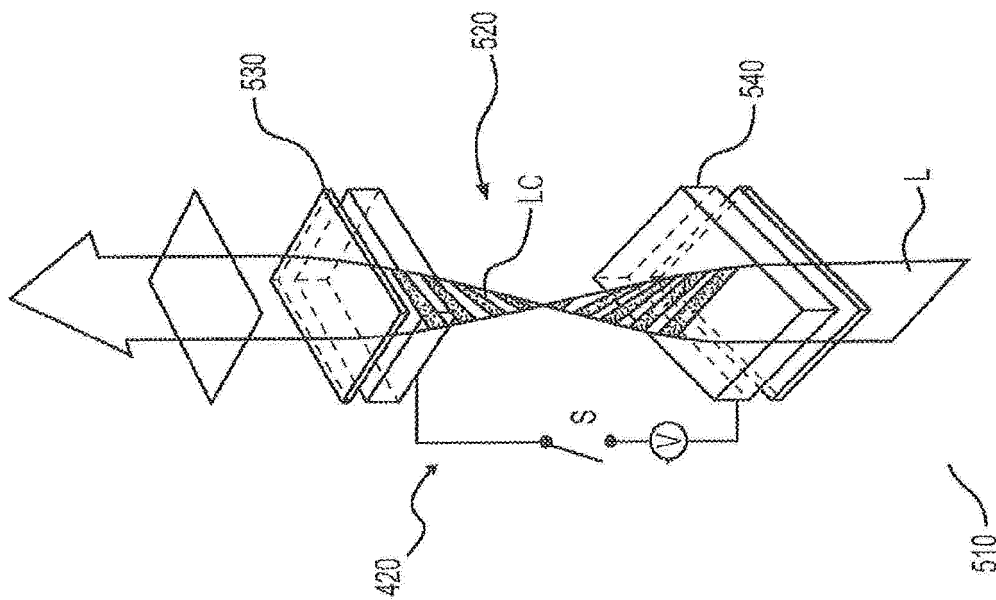


FIG. 5A

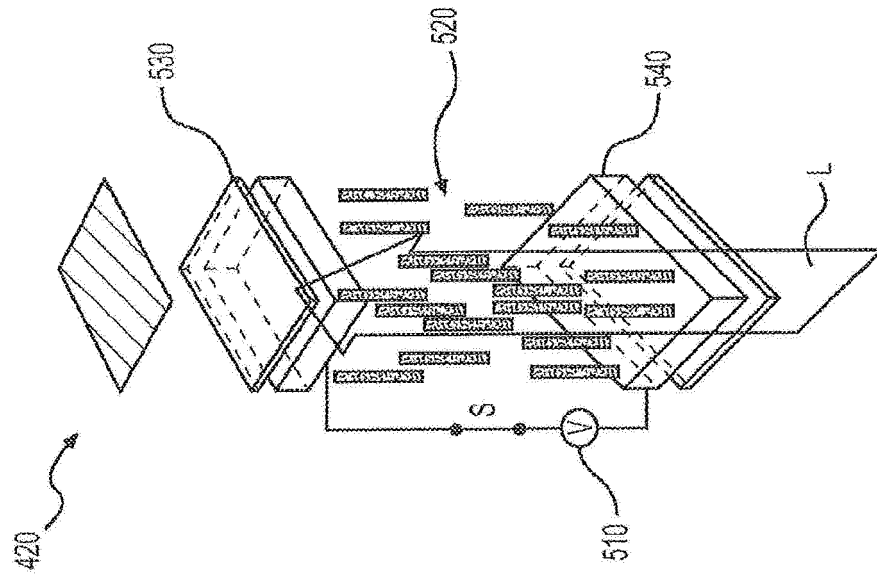
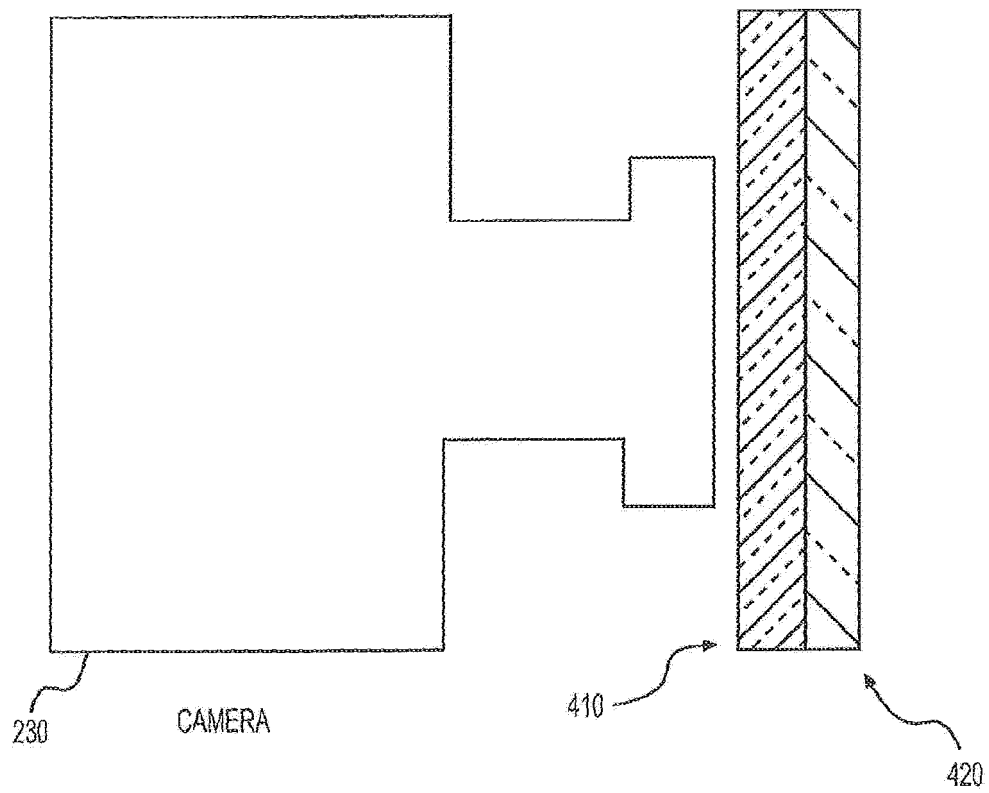


FIG. 5B



**FIG. 6**

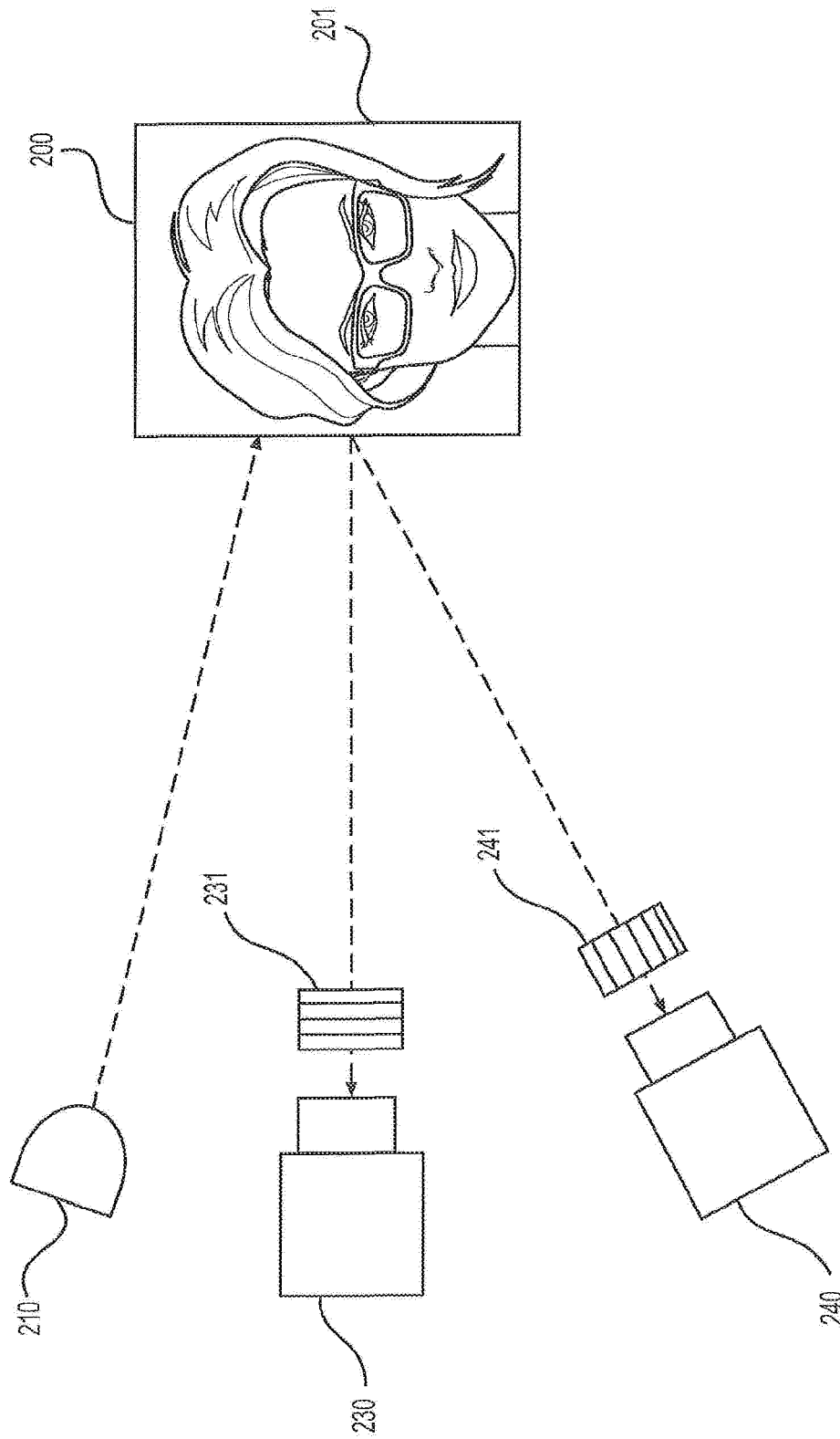


FIG. 7



## EUROPEAN SEARCH REPORT

Application Number  
EP 18 17 5187

5

10

15

20

25

30

35

40

45

50

55

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
X	WO 2011/083433 A1 (3D SWITCH S R L [IT]; PENNISI DARIO [IT]; CAMELLI ANTONIO [IT]) 14 July 2011 (2011-07-14) * figure 2 * * page 7, lines 12-14 * * page 8, lines 3-6,10-14 * * page 8, line 30 - page 9, line 5 * * page 9, lines 14-25 * * page 19, lines 19-25 * * page 12, line 25 - page 13, line 28 * * page 16, lines 14-17 *	1-15	INV. G02F1/1335 G02B5/30 G02B27/28 G02C7/12 G02B27/00 G01N21/21 G02B27/01
A	JP 2012 103331 A (DENSO CORP) 31 May 2012 (2012-05-31) * paragraph [0028] *	3,5,7	
A,P	WO 2017/188276 A1 (KYOCERA CORP [JP]) 2 November 2017 (2017-11-02) * detection unit 52; figure 5 *	1-15	
A,P	US 2017/336864 A1 (BROZ MICHAL [US] ET AL) 23 November 2017 (2017-11-23) * paragraphs [0023], [0031], [0037], [0040] - [0042] *	1-15	TECHNICAL FIELDS SEARCHED (IPC) G02F G02B G02C G01N
The present search report has been drawn up for all claims			
Place of search Munich		Date of completion of the search 5 October 2018	Examiner Haan, Martine
<p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document</p> <p>T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons &amp; : member of the same patent family, corresponding document</p>			

EPO FORM 1503 03.82 (P04C01)



**ANNEX TO THE EUROPEAN SEARCH REPORT  
ON EUROPEAN PATENT APPLICATION NO.**

EP 18 17 5187

5

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
The members are as contained in the European Patent Office EDP file on  
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-10-2018

10

15

20

25

30

35

40

45

50

55

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
WO 2011083433 A1	14-07-2011	CN 102822848 A	12-12-2012
		EP 2521988 A1	14-11-2012
		IT 1397294 B1	04-01-2013
		JP 2013516882 A	13-05-2013
		KR 20120102153 A	17-09-2012
		US 2013002839 A1	03-01-2013
		WO 2011083433 A1	14-07-2011
-----			
JP 2012103331 A	31-05-2012	NONE	
-----			
WO 2017188276 A1	02-11-2017	JP 6297238 B1	20-03-2018
		JP WO2017188276 A1	17-05-2018
		WO 2017188276 A1	02-11-2017
-----			
US 2017336864 A1	23-11-2017	NONE	
-----			